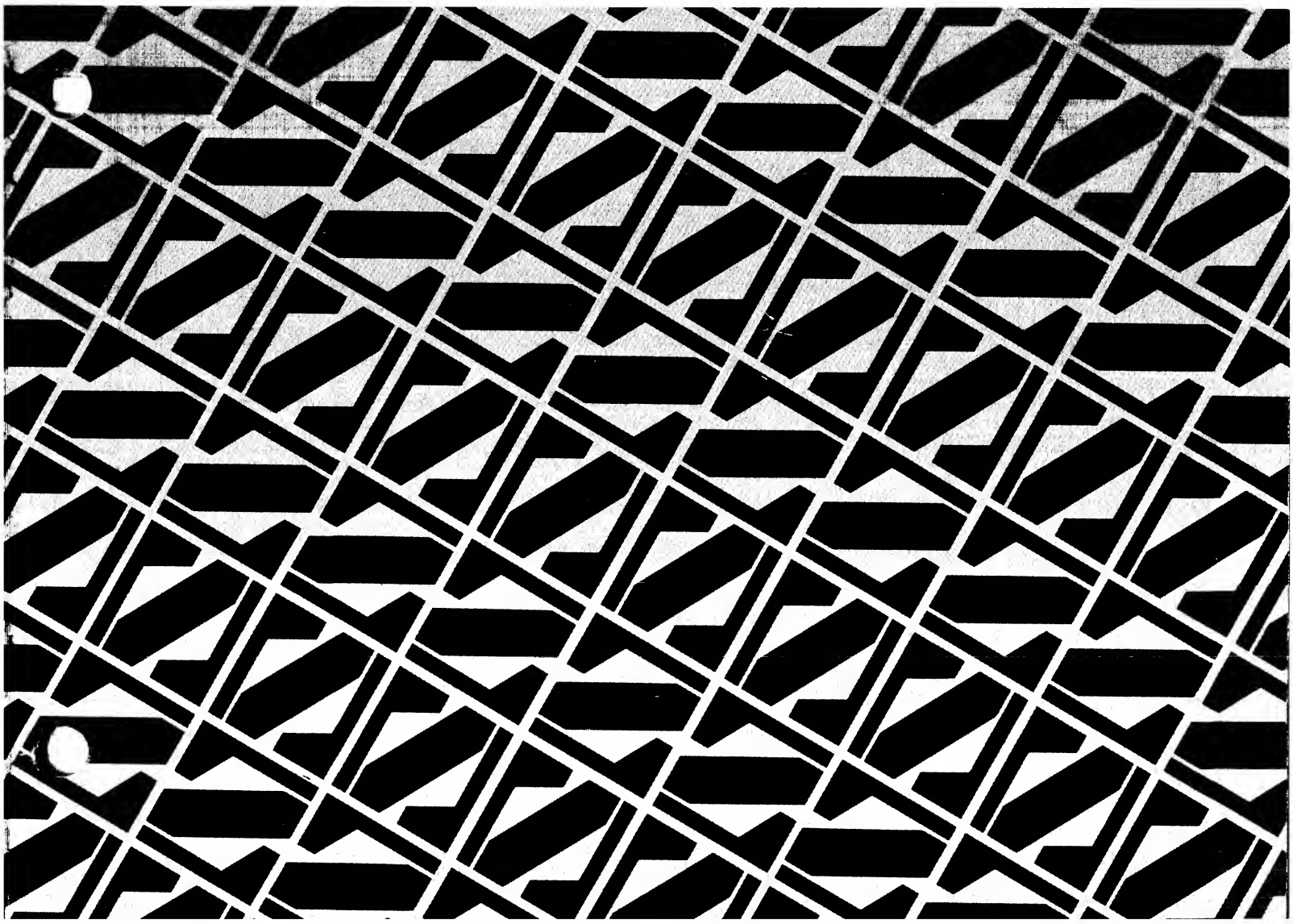
National Semiconductor
Order No. IMP-16S/118YC
Pub. No. 4200018C

Timesharing Users Manual



Order No. IMP-16S/118YC
Publication No. 4200018C

TIMESHARING USERS MANUAL

April 1974

© National Semiconductor Corporation
2900 Semiconductor Drive
Santa Clara, California 95051

PREFACE

This manual is divided into two parts. The first part consists of user information to enable a programmer to assemble IMP-8 or IMP-16 programs with the use of the timesharing service of Tymshare, Inc. The second part of this manual consists of user information for a programmer to assemble IMP-16 programs with the use of the General Electric, Information Service, Computer Timesharing facility.

Operating instructions for the following programs are described in this document.

Function	TYMSHARE		General Electric
	IMP-16 Program	IMP-8 Program	IMP-16 Program
Program Assembly	ASM16	ASM8T	ASM16$
RLM Deck or Tape Punch	PRLMT	PRLM8	PRLMG$
CRB Deck Punch (Card Reader Bootstrap)	PCRBT	-	PCRB$
P-N PROM Tape Punch	PROMT	PROM8	PROM$

Changes to this manual will be provided in the form of change pages to be added to or to replace pages in this issue. Such changes will be reflected in a List of Effective Pages.

This publication is provided for information purposes only and is subject to change without notice.

Copies of this publication and other National Semiconductor publications may be obtained from the sales offices listed on the back cover.

CONTENTS

		Page
PART I	GUIDE TO USE OF TYMSHARE FACILITIES	
	INTRODUCTION	1-1
	TELETYPE CONFIGURATION RESTRICTIONS	1-2
	LOG-IN PROCEDURE	1-2
	OVERVIEW OF MAJOR PROGRAMMING ACTIVITIES	1-2
	COMPOSING AND EDITING PROGRAMS	1-2
	USING EDITOR	1-3
	USING TECO	1-3
	RUNNING THE ASSEMBLER	1-6
	OBTAINING PRINTOUT	1-6
	OBTAINING PROGRAM OUTPUT	1-7
	TAPE FORMAT	1-7
PART II	GUIDE TO USE OF GENERAL ELECTRIC COMPUTER TIMESHARING FACILITY	
	INTRODUCTION	2-1
	TELETYPE CONFIGURATION RESTRICTIONS	2-2
	HOW TO OBTAIN ASM16$, PRLMG$, PCRB$, and PROM$	2-2
	HOW TO ACCESS THE COMPUTER	2-2
	HOW TO SIGN OFF	2-3
	OVERVIEW OF MAJOR PROGRAMMING ACTIVITIES	2-3
	CREATING AND EDITING USER'S PROGRAM	2-6
	RUNNING THE ASSEMBLER	2-8
	OBTAINING PRINTOUT	2-8
	AUXILIARY PROGRAMS	2-9
	CR BOOT OUTPUT	2-10
	PROM TAPE	2-11
Appendix A.	EXECUTING BATCH REQUESTS ON TYMSHARE	A-1
Appendix B.	COMPUTER PROGRAM EXAMPLES RUN ON TYMSHARE	B-1
Appendix C.	ASSEMBLY EXAMPLE RUN ON GENERAL ELECTRIC COMPUTER TIMESHARING SERVICE.	C-1

PART I

GUIDE TO USE OF TYMSHARE FACILITIES

INTRODUCTION

This part of the manual describes the use and operation of the IMP-16 and IMP-8 assemblers under control of the national timesharing service of Tymshare, Inc. Instructions are provided for (1) preparing and editing source programs in assembly language using any of the standard Tymshare editors, (2) assembling these programs into IMP-16 or IMP-8 binary code, and (3) converting these programs into media suitable for loading into an IMP-16 or IMP-8 microprocessor.

The following references complement the instructions given herein. References 1 through 4 describe the hardware of each of the applicable microcomputers, including their instruction sets. References 5 and 6 describe the IMP-16 and IMP-8 assemblers, respectively. Reference 7 describes the program DEBUG and the loader programs that have been developed for the IMP-16 computers. Reference 8 describes the debugging and loader programs for the IMP-8 computer. Reference 9 explains use of the Tymshare facilities pertinent to instructions given in this manual.

References:

1. IMP-16L Users Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-16L/928

2. IMP-16C Application Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-16C/921

3. IMP-8P Users Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-8P/933

4. IMP-8C Application Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-8C/932

5. IMP-16 Programming and Assembler Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-16S/102Y

6. IMP-8 Programming and Assembler Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-8S/134Y

7. IMP-16 Utilities Reference Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-16S/025Y

8. IMP-8 Utilities Reference Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-8S/040Y

9. TYMEX for TYCOM-X System, Tymshare, Inc.

In addition to the basic assembly function, the assemblers perform a number of diagnostics, checking for such things as duplicate labels, illegal mnemonics, illegal addresses, or constants that are not within the allowable range. These assembler functions are described in references 5 and 6.

TELETYPE CONFIGURATION RESTRICTIONS

If your Teletype is equipped with the Automatic Answerback facility, this facility must be disabled or faulty object paper tapes may result.

LOG-IN PROCEDURE

To use the system, one must first log in to Tymshare's PDP-10 computer system. The log-in procedure consists of dialing the computer center, connecting the terminal to the phone line, and following the standard log-in procedure.

When successfully logged in, the terminal indicates it is ready to accept commands by typing a prompt character ('.' - PDP10 mode, '-' TYMEX mode) at the left side of the page.

OVERVIEW OF MAJOR PROGRAMMING ACTIVITIES

Figure 1-1 provides a flowcharted overview of the use of the Tymshare System for preparing programs. The procedure for the major activities in the flowchart are described in the remainder of this manual. The major activities, after logging into the Tymshare System, are as follows:

1. Compose program
2. Edit program
3. Execute assembler, specifying file name of source program
4. If required, obtain printout of assembled program
5. If required, correct error in assembled program
6. If required, convert assembled program to desired loading medium
7. Exit from Tymshare System

COMPOSING AND EDITING PROGRAMS

In order to assemble a source program, the user must first enter his source program into the Tymshare System using its file creation capabilities. To do this, the user must first execute a command to create his file and then he must type his program into the file. When the program has been completely entered into the file, the user must save the file so it is stored at the computer and is available for use by an assembler.

The user must assign a name to the file. This name will serve to identify the file both to the user and to the assembler. By convention, all assembly input (source) files should be named "name" with no file extension, where "name" is any valid file name containing one to five alpha-numeric characters. Examples of valid file names are SORT and PRNT3.

There are two editors currently available with Tymshare for editing IMP-16 source programs: EDITOR, available in the TYMEX mode, and TECO, available directly on the PDP-10 system. For the general user, EDITOR is recommended because it is easier to use and the user is less likely to make mistakes with it than with TECO. Information about the use of either of these editors is available from Tymshare, Inc.

USING EDITOR

NOTE

When typing commands, the following notation applies. The symbol " ↵ " signifies typing a carriage return. The notation "C^{C}" signifies typing "control C" (hold down control key and type C).

To use EDITOR, the user must be in TYMEX mode. In order to change to TYMEX mode after the monitor has typed a period (.), signaling its readiness to accept a command, the user should type

.TYMEX ↵

The terminal will switch to TYMEX mode and will prompt the user with a dash (-) to indicate that it switched and that it is ready to accept commands. To edit a file with EDITOR, the user should type EDITOR following the dash.

- EDITOR ↵

EDITOR will be loaded and will prompt the user with an asterisk (*). The user may then create a new file by typing:

* APPEND ↵

and then entering as many lines of text as desired, terminated by a Control D (D^{C}) following the last line of text.

If the user desires to edit an existing file, he should type

* READ filename ↵

to read the file into the text area. He may then make the desired changes using EDITOR commands.

Whether creating a new file or editing an existing file, upon completion the user may save his new data by typing

* WRITE filename ↵

All of the EDITOR commands are described in the Tymshare Reference Manual "EDITOR" and on pages 9-14 of Tymshare Manual TYMEX.

After using the EDITOR, typing the command

* QUIT ↵

returns the terminal to TYMEX mode.

USING TECO

TECO is a very powerful character-oriented editor that is capable of accepting a few simple commands to perform a number of complex functions. However, because of the power of TECO, it is possible for a novice user to make catastrophic mistakes, and, thus, it is recommended for use only by a person thoroughly familiar with it.

To create and edit a file with TECO, the user should type

- MAKE filename ↵

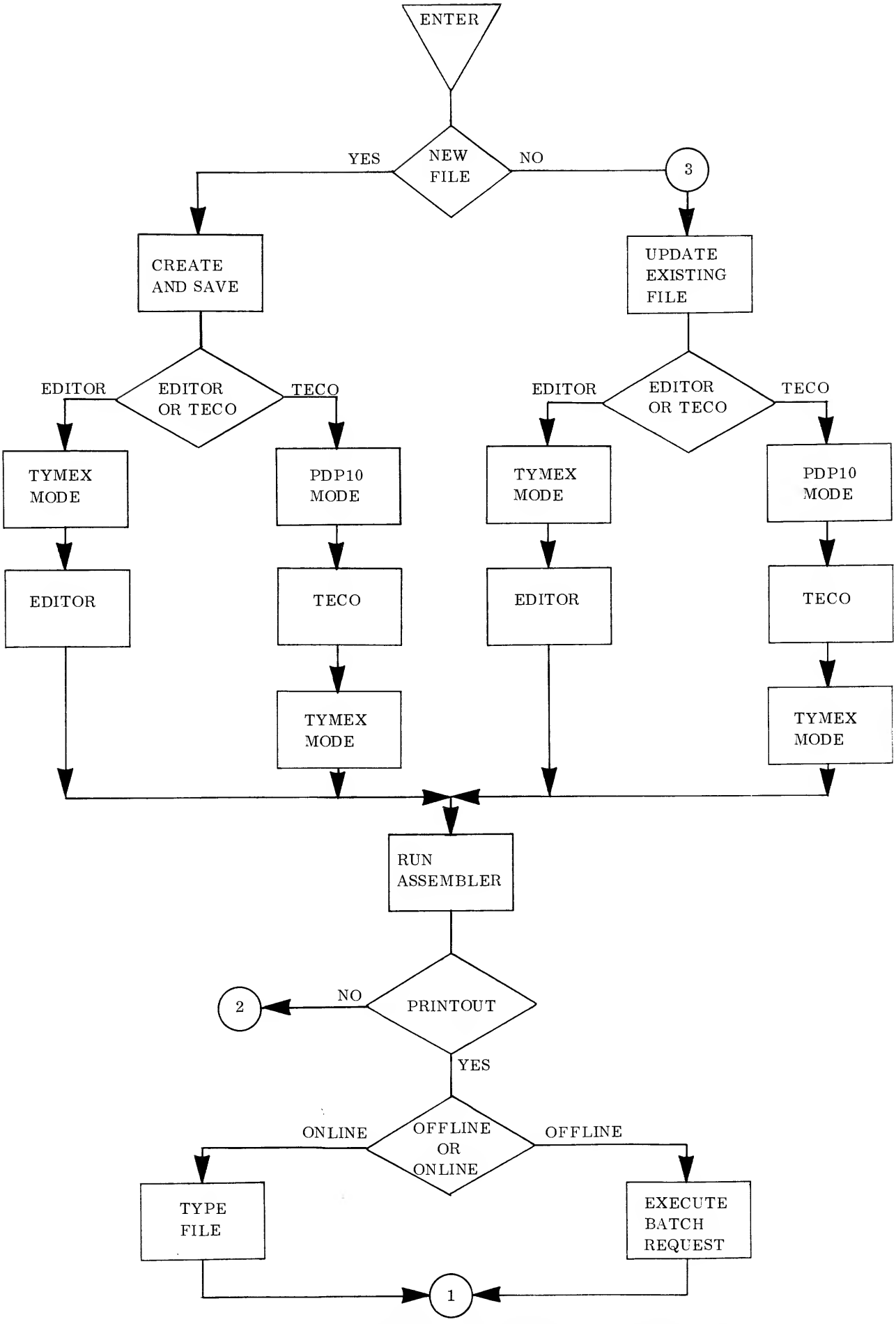


Figure 1-1. Program Preparation for Tymshare System (Sheet 1 of 2)

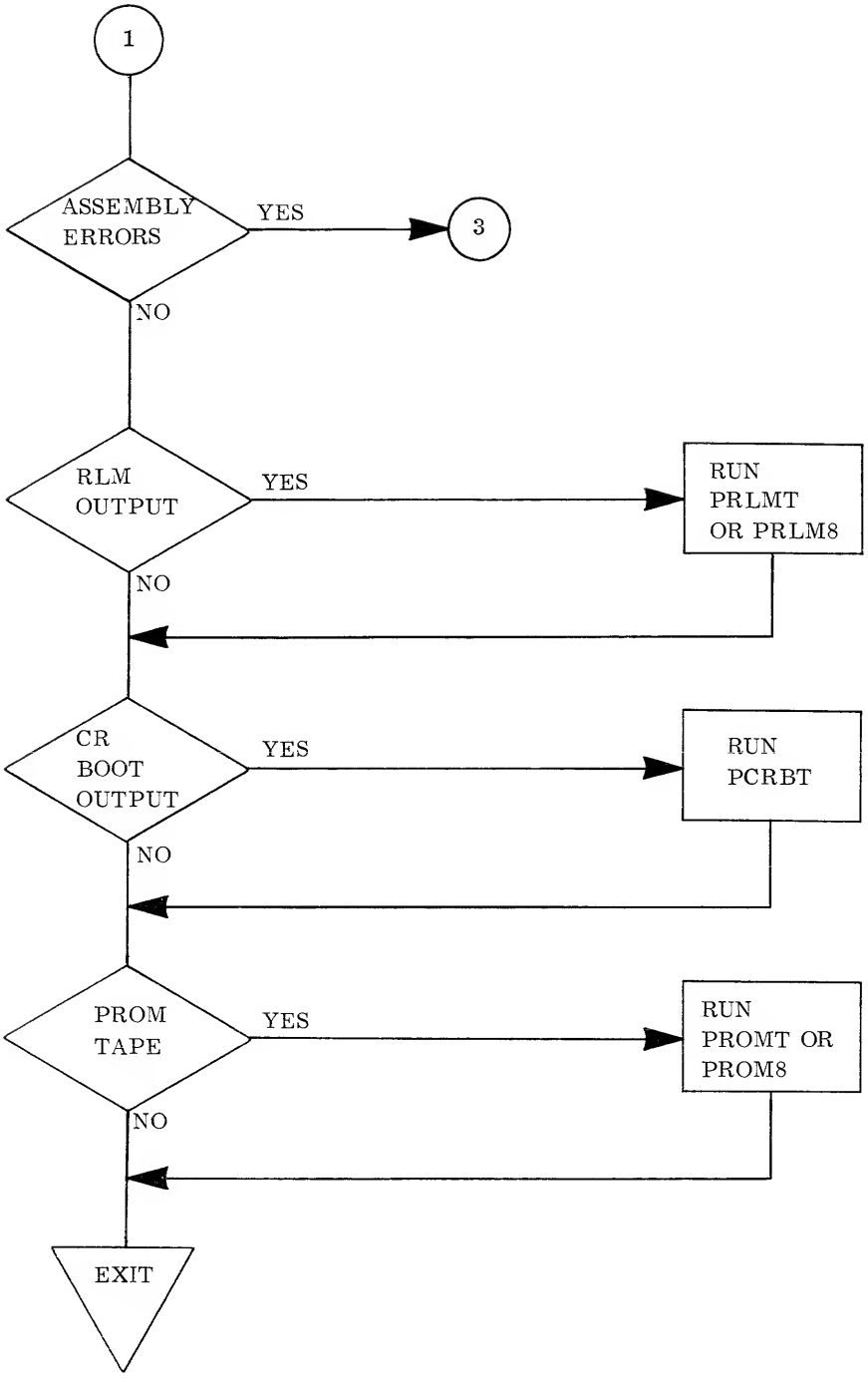


Figure 1-1. Program Preparation for Tymshare System (Sheet 2 of 2)

To edit an existing file with TECO, the command is

-TECO filename ↵

TECO indicates that it is ready to accept a command by typing an asterisk (*).

TECO is described on pages 8-69 through 8-89 of the PDP-10 Timesharing Handbook and in the TECO section of the PDP-10 Reference Handbook.

RUNNING THE ASSEMBLER

Once the program has been stored on the PDP-10 disk, it may be assembled into binary code by running the correct assembler. To execute the assembler, the user must type while in the TYMEX mode

-R(NSC)ASM16 ↵

or -R(NSC)ASM8T ↵

The system then loads and executes the requested assembler. When the assembler begins execution, it types

ENTER SOURCE FILE NAME

The user should then type the name of the disk file that contains the source program to be assembled and, then, a carriage return. The assembler will generate an output listing file on disk with the file name "name. L16 (name. L8)" and an object file on disk with the file name "name. O16 (name.O8)".

OBTAINING PRINTOUT

On-Line Method

After the assembly is completed, the user may cause his assembly listing to be printed on his terminal by typing

-TYPE filename.Lxx/FOR ↵

where xx represents "16" for the IMP-16 or "8 blank" for the IMP-8. However, instead of typing the above notation, if a terminal with a wide print span is available, he may first request a wide listing by typing

-TTY WIDTH 132 ↵

-TYPE filename.Lxx/FOR ↵

Off-Line Method

The user may instead request an off-line listing on the TYMSHARE line printer by executing a BATCH request (see Appendix A), requesting a listing with forms control.

OBTAINING PROGRAM OUTPUT

If the user desires to punch his object file in a format acceptable to IMP loaders (described in references 7, 8, and 9) while in the TYMEX mode, he may execute either the program PRLMT or PRLM8 by typing

-R(NSC) PRLMT ↵

-R(NSC) PRLM8 ↵

The program will first query the user for an input file name in the same manner as the assembler and then will type

OUTPUT DEVICE (CDP/PTP/TTY)

The user should enter the appropriate device name (CDP for card punch, PTP for high-speed paper-tape punch, or TTY for user's terminal tape punch) followed by a carriage return. The output file for PRLMT is "filename.R16" and the output file for PRLM8 is "filename.R8". These filenames may be referenced when submitting BATCH requests (see Appendix A) for high-speed paper-tape output or card output.

Card decks in a format suitable for loading by CRBOOT or paper tapes suitable for input to ROM generation may be obtained by typing

-R(NSC)PCRBT ↵ (for CRBOOT format)

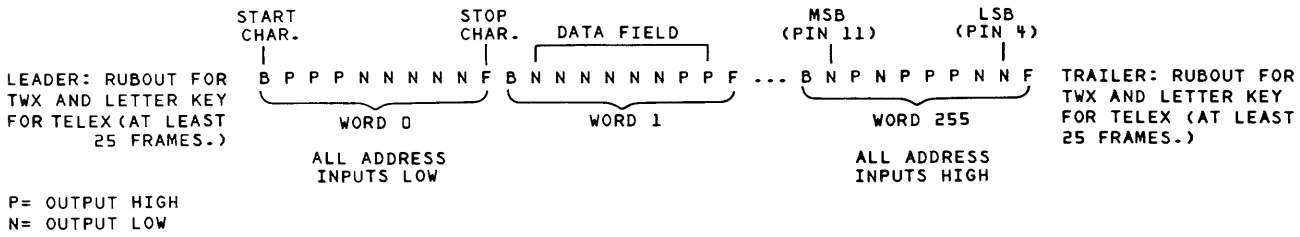
-R(NSC)PROM8 ↵ (for programming IMP-8 PROMS)

-R(NSC)PROMT ↵ (for programming IMP-16 PROMS)

In the same manner as above, each of these programs will also query for the input file name.

TAPE FORMAT

The paper tape generated by PROMT or PROM8 contains 7-bit ASCII characters (as generated by the Model 33 TTY) in the following format:



NOTE

This format may be used when ordering ROM's or PROM's from National Semiconductor Corporation.

The tape generated will contain the following:

- 40 RUBOUT characters
- Data for bits 15 through 8 of a 256-word block
- 40 RUBOUT characters
- 10 NULL characters
- 40 RUBOUT characters
- Data for bits 7 through 0 of the 256-word block
- 40 RUBOUT characters

PROM8

PROMT

The content of the tape will be printed on the terminal, four words per line, as shown in figure 1-2. The printout for an 8-bit PROM will show only data for bits 7 through 0.

Card or high-speed paper tape output from PRLMT, PRLM8, or PCRBT may be obtained by executing a BATCH request (see Appendix A). The following files are created by the above utility programs:

Program	Output File
PCRBT	filename. B16

Examples of computer runs, including BATCH requests, are presented in Appendix B. Many of the examples relate to the IMP-16 Assembler, but if appropriate file and program names are modified, they are effective for the IMP-8 also.

PRINTOUT	SIGNIFICANCE OF DATA
ENTER SOURCE FILE NAME ROMDI	
TURN ON PAPER TAPE PUNCH	
BPNNNNNNPFBPPPPNNNPFBNNPNNNNPFBNNPNNNNPF	Bits 15-8, Words 0 - 3
BPPPPNNNPFBNNPNNNNPFBPNPNNNNNFBPPPNNNNPF	Bits 15-8, Words 4 - 7
BNNPNNNNPFBNNPNNNNPFBNPNNPNNNFBNNPNNNNPF	Bits 15-8, Words 8 - 11
BNNNPNNNPFBNNPNNNNPFBNPNPNNNNFBPPPPNNNPF	Bits 15-8, Words 12 - 15
• • •	• •
• • •	• •
• • •	• •
BPNNNPNNPFBPPPNPNNPFBNNPNNNNPFBPNNNPNNPF	Bits 15-8, Words 244 - 247
BPPPNPNNPFBNNPNNNNPFBNNPNNNNPFBPNNNNPNPF	Bits 15-8, Words 248 - 251
BPPPNNPNPFBNNPNNNNPFBNNPNNNNPFBNNPPNNNNF	Bits 15-8, Words 252 - 255
BNPNPPPNNFBNPNPPNPPFBNNNNNNNPFBNPPPPPPNF	Bits 7-0, Words 0 - 3
BNPNPPNNPFBNPPPPPNNFBNNNNPNPNFBNPNPNPPPF	Bits 7-0, Words 4 - 7
BNNNNNNNPFBNPPPPNNNFBNNNNNNNPFBNPNPPPPPF	Bits 7-0, Words 8 - 11
BNNNNNNNPFBNPPPNPNNFBNNNNNNNNFBNPNNPPNPF	Bits 7-0, Words 12 - 15
• • •	• •
• • •	• •
• • •	• •
BNNNPPNNPFBNNNPPNNPFBPNNNPNPPFBNNNPNPPPF	Bits 7-0, Words 244 - 247
BNNNPNPNPFBNNNNNNNPFBPNNNNPPPFBNNNPPNNPF	Bits 7-0, Words 248 - 251
BNNNNPNPNFBNNNNNNNPFBPNNNNNPPFBPNNNNNNPF	Bits 7-0, Words 252 - 255
EXIT	

Figure 1-2. Example of 16-bit PROM Paper Tape Printout

PART II

GUIDE TO USE OF GENERAL ELECTRIC COMPUTER TIMESHARING FACILITY

INTRODUCTION

This part of the manual describes the use and operation of the IMP-16 Cross Assembler under control of the national timesharing service of General Electric. Instructions for the user are given for (1) preparing and editing his source programs in IMP-16 assembly language using any of the standard General Electric editors, (2) assembling these programs into IMP-16 binary code, and (3) converting these programs into media suitable for loading.

References:

1. IMP-16C Applications Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-16C/921

2. IMP-16 Programming and Assembler Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-16S/102Y

3. IMP-16 Utilities Reference Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-16S/025Y

4. IMP-16L Users Manual, National Semiconductor Corporation, Santa Clara, California, Order Number IMP-16L/928

5. Timesharing System Manual, General Electric Company, Palo Alto, California, Publication Number 711223, Mark II

6. Command System, General Electric Company, Palo Alto, California, Publication Number 3501.011, Mark III Foreground Reference Manual

7. Editing Commands, General Electric Company, Palo Alto, California, Publication Number 3400.01F, Mark III Foreground Reference Manual

8. RMS Remote Media Services, General Electric Company, Palo Alto, California, Publication Number 3710.04B, Mark III Foreground Reference Manual

The referenced publications complement the information herein. References 1 and 4 describe the hardware of each of the applicable microcomputers, including their instruction sets. References 2 and 3 describe the IMP-16 assembler program and the utility programs, respectively. References 5, 6, 7, and 8 describe the use of the General Electric Company timesharing facilities that pertain to running the National Semiconductor IMP-16 programs.

Users need not be programmers. However, familiarity with the system is required. The General Electric Timesharing System Manual (reference 5) provides information concerning operation and should be used to supplement the operating information contained herein. The Command System Manual (reference 6) describes the operating commands necessary to operate the timesharing system, and the Editing Commands Manual (reference 7) describes the commands needed to edit the IMP-16 programs. Reference 8 contains information about the Remote Media Service provided by General Electric. This service referred to in the text may be used to obtain punched card output.

TELETYPE CONFIGURATION RESTRICTIONS

If your Teletype is equipped with the Automatic Answerback facility, this facility must be disabled or faulty object paper tapes may result.

HOW TO OBTAIN ASM16$, PRLMG$, PCRB$, and PROM$

The above listed programs are available from the General Electric Timesharing Service. Contact the local representative of the General Electric Timesharing Computer Service in your area and ask for validation on the NAQ54 catalog. A local General Electric representative is listed in most telephone books under General Electric Company, Timesharing Computer Service. If you are unable to locate a General Electric representative in your area, call the Palo Alto, California office of General Electric, Timesharing Computer Service.

HOW TO ACCESS THE COMPUTER

In all of the examples below, the data typed in by the user are underlined to distinguish them from the data printed out by the computer. Pressing the carriage return key is represented by (CR) . Use the following procedure to access the General Electric Timesharing computer.

1. Turn on the terminal. If the terminal can be set to LOCAL or LINE, set it to LINE.

2. Telephone the local General Electric Timesharing Computer.

3. When you hear the ringing stop, and then a high-pitched whistle start, place the telephone handset on the acoustic coupler. Type the letter H; then, press the carriage return key. The terminal will then reply with the following:

   ```
   U#=
   ```

4. Type your user number, a comma, and your password; then, press the carriage return key. The computer will accept your user number and password and will type the following:

   ```
   ID:
   ```

   Or, if the computer does not recognize your user number, and/or the password is incorrect, the computer will type:

   ```
   VALIDATION FAULT, RETYPE IT--
   ```

   Retype your user number, a comma, your password, and the carriage return.

5. When the computer types ID: , type your project number or project identifier; then, press carriage return. The computer will reply with:

   ```
   SYSTEM-
   ```

6. Type in FIV (for FORTRAN IV) and carriage return. The computer will reply with:

   ```
   NEW OR OLD-
   ```

7. If you are setting up a new data file, type NEW; if you want to work on a previously saved file, type OLD. Follow either entry with carriage return.

8. The computer will reply with:

   ```
   ENTER FILE NAME--
   ```

If you are setting up a new file, assign it a name (up to 8 characters); if you are recalling an "old" file type in the name of the file, followed with a carriage return. The computer will signal that the requested file is set-up with the message:

```
READY
```

You can now set up the new file or perform an analysis using your old file. Each line of the file should have a line number followed by at least one space. The contents of a line can be changed by simply retyping the same line number followed by the new text desired as long as the file is still being actively processed (prior to the SAVE command). The computer automatically replaces the old line with the new one bearing the same line number. When a file is completed, it should be stored permanently in the computer. To store a new file, type SAVE. To replace an old file, type REPLACE. The computer saves the file and types out READY. Editing cannot be performed on a file that was printed out as the result of a LIST command. Details of the data file are discussed in the following paragraphs.

HOW TO SIGN OFF

To terminate the timesharing operation, one of the following operations may be performed:

1. Remove handset from the acoustic coupler and hang up.

2. Type in GOODBYE or BYE, followed with a carriage return. The computer will reply with the total number of CRUs used, the terminal connect hours, and the number of input/output kilo characters transmitted.

To terminate a project, and immediately re-establish access to the computer for a new project, terminate the old project by typing in H or HELLO, followed by a carriage return. The computer will terminate the old project and will set up the new project with the message:

```
U#=
```

Repeat the sign-on procedures described in the paragraph titled, HOW TO ACCESS THE COMPUTER, from step 4, onward.

OVERVIEW OF MAJOR PROGRAMMING ACTIVITIES

Figure 2-1 provides a flowchart overview of the use of the General Electric, Timesharing Computer System for preparing user's IMP-16 programs. The procedures for the major activities in the flowchart are described in the following paragraphs. The major activities after logging into the General Electric System follow:

1. Create Program

2. Edit Program

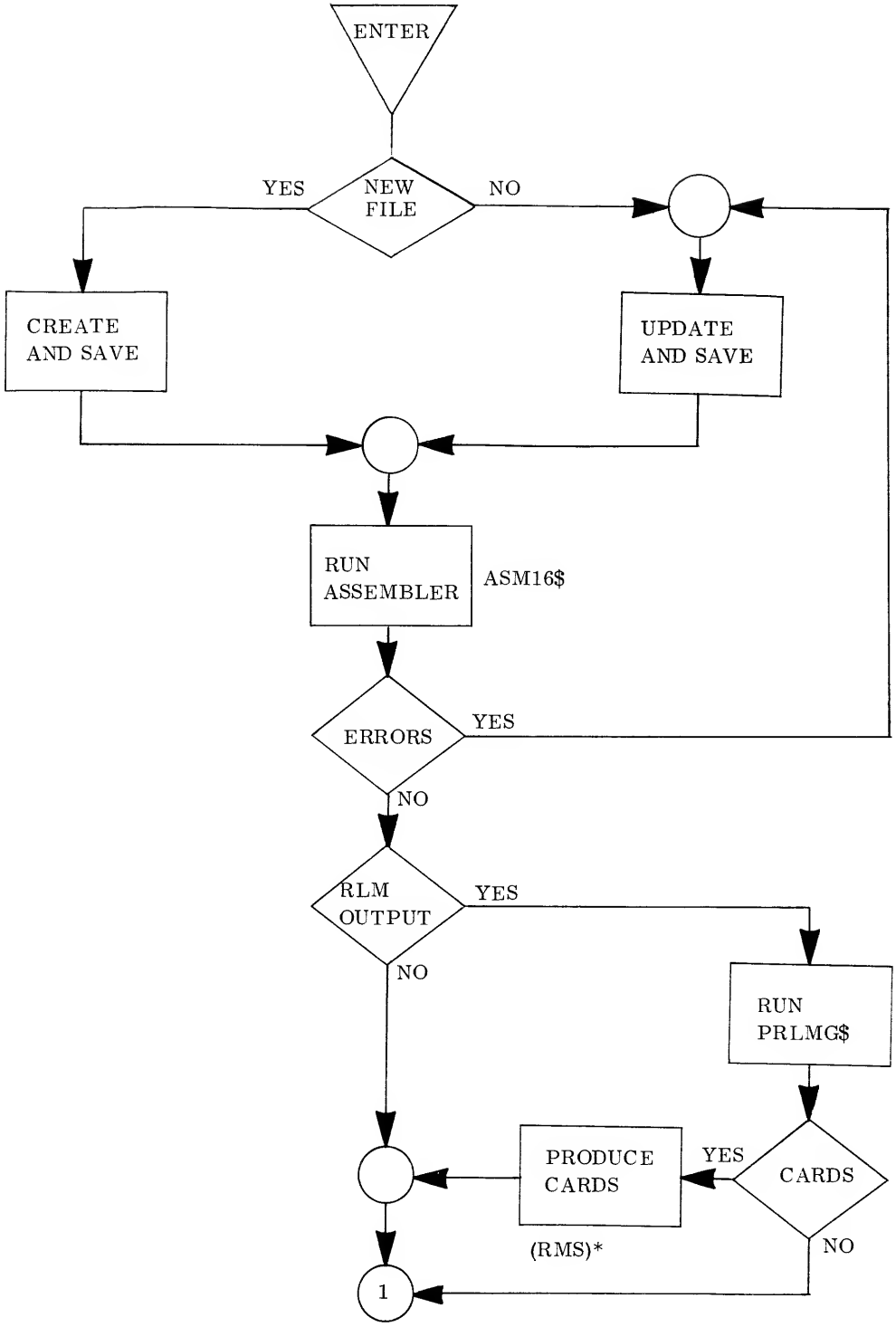
3. Call Assembler (ASM16$)

4. Enter name of source program

5. If required - Obtain printout of assembled program

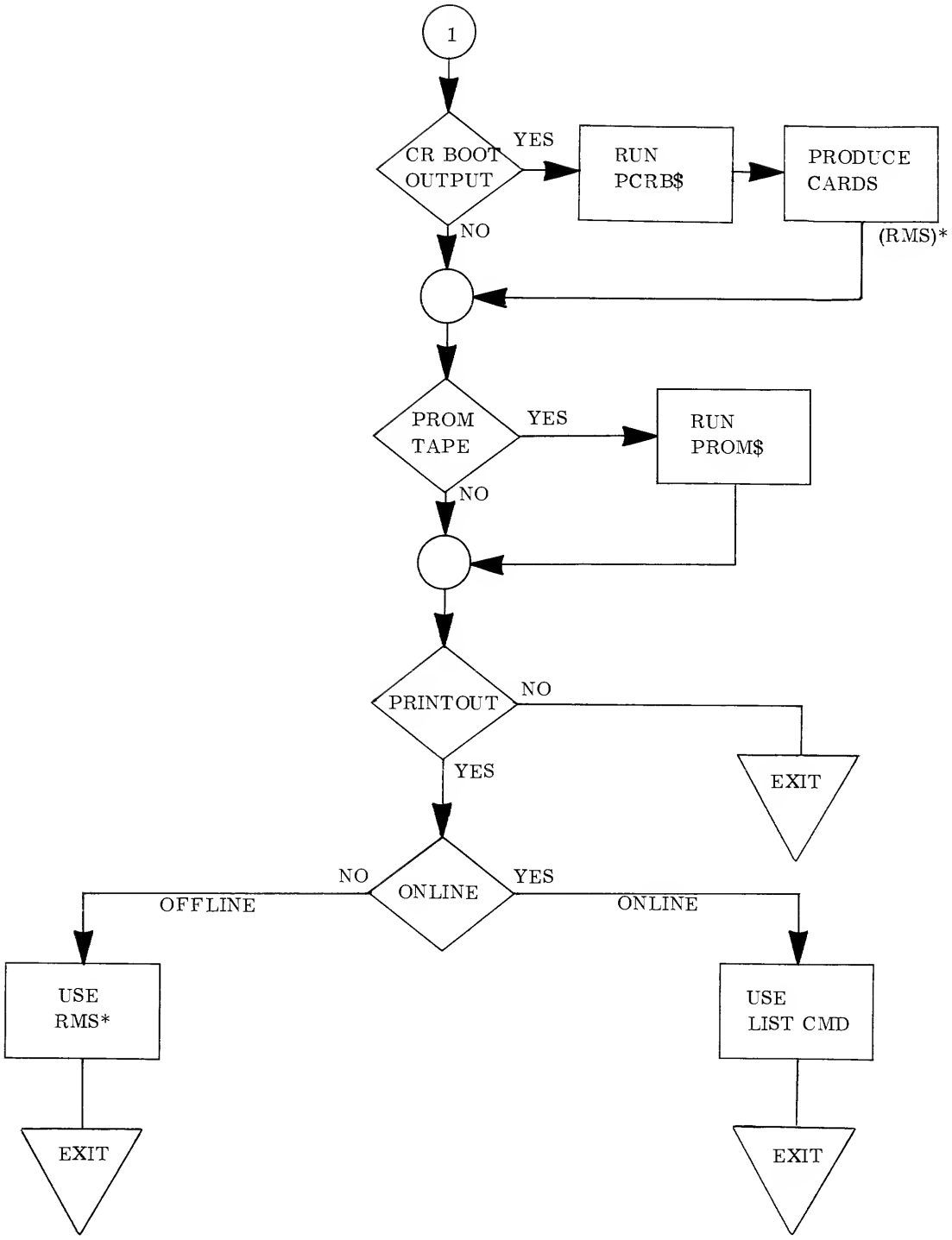
6. If required - Correct errors in assembled program

7. If required - Prepare desired loading medium of assembled program



*See RMS Manual (reference 8).

Figure 2-1. Program Preparation for General Electric System
(Sheet 1 of 2)



*See RMS Manual (reference 8).

Figure 2-1. Program Preparation for General Electric System (Sheet 2 of 2)

CREATING AND EDITING USER'S PROGRAM

In order to assemble an IMP-16 program, the user must first enter his source program into the General Electric Timesharing System using its file creation capabilities. To do this, the user must execute the commands shown below and then type in his source programs. In the example below, as in all examples in this manual, user input is underlined and comments are typed in lower case. The assembled version of this example is shown in Appendix C.

```
U#=NAQ54000,PSWD (CR)
ID:IDENT (CR)
SYSTEM-FIV (CR)
OLD OR NEW-NEW (CR)
FILE NAME-SOURCE (CR)


100             .TITLE  TTYIO (CR)
110             .GLOBL  RTTY,WTTY (CR)
120 ; (CR)
130 ;  RTTY . READ A CHARACTER FROM TTY INTO AC0. (CR)
140 ; (CR)
150             .LOCAL (CR)
160 $SV3:       .WORD   0 (CR)
170 TTY         =       1*8 (CR)
180 READ        =       2 (CR)
190 R3          =       3 (CR)
200 RTTY:       ST      R3,$SV3 (CR)
210             LI      R3,TTY (CR)
220 $RTY1:      RIN     READ (CR)
230 POA         =       12 (CR)
240             BOC     POA,$RTY2 (CR)
250             JMP     $RTY1 (CR)
260 $RTY2:      JSR     WTTY (CR)
270             LD      R3,$SV3 (CR)
280             RTS (CR)
290 ; (CR)
300 ;  WTTY . WRITE A CHARACTER TO TTY FROM AC0 (CR)
310 ; (CR)
320             .LOCAL (CR)
330 $SV3:       .=.+1 (CR)
340 WRITE       =       7 (CR)
350 WTTY:       ST      R3,$SV3 (CR)
360             LI      R3,TTY (CR)
370 $WTY1:      ROUT    WRITE (CR)
380             BOC     POA,$WTY2 (CR)
390             JMP     $WTY1 (CR)
400 $WTY2:      LD      R3,$SV3 (CR)
410             RTS (CR)
420             .END (CR)


READY

SAVE SOURCE (CR)
```

Save the file with the name SOURCE for future reference.

In the preceding example note the use of line numbers. These are for the user's benefit and are ignored by ASM16$. Note also that a rather rigid format was chosen to type in the program. This is referred to as fixed field format. We could just as easily have used free field format (the ASM16$ program makes no distinction) as shown in the listing below, but it would not have been as readable.

```
LIST INPUT (CR)                    Print out contents of file previously saved as "INPUT."

INPUT          14:17PDT       02/15/74

100 .TITLE TTYIO,'TELETYPE INPUT.OUTPUT'
110 .GLOBL RTTY,WTTY
120 ;
130 ;RTTY.READ A CHARACTER FROM TTY INTO AC0.
140 ;
150 .LOCAL
160 $SV3: .WORD 0
170 TTY = 1*8
180 READ = 2
190 R3 = 3
200 RTTY: ST R3,$SV3
210 LI R3,TTY
220 $RTY1: RIN READ
230 POA = 12
240 BOC POA,$RTY2
250 JMP $RTY1
260 $RTY2: JSR WTTY
270 LD R3,$SV3
280 RTS
290 ;
300 ;WTTY.WRITE A CHARACTER TO TTY FROM AC0.
310 ;
320 .LOCAL
330 $SV3: .=.+1
340 WRITE = 7
350 WTTY: ST R3,$SV3
360 LI R3,TTY
370 $WTY1: ST R3,$SV3
380 BOC POA,$WTY2
390 JMP $WTY1
400 $WTY2: ROUT WRITE
410 RTS
420 .END
```

Once you have created and saved your program, you may wish to make changes to it. To do this, first call up your program by typing in "OLD" and the name of your file. Then to delete a line merely type in the line number and hit a carriage return; to add or change a line, type in the line number and the new information. When all your changes are made, be sure to type "REP" to save the corrected version on your file. The following example illustrates these techniques.

```
READY

OLD (CR)

ENTER FILE NAME-SOURCE (CR)

READY

120 (CR)                          Delete line 120
130 ; COMMENT (CR)                Change line 130
150 (CR)                          Delete line 150
135 ; ADD THIS LINE (CR)          Add line 135
EDI LIST 110-170 (CR)             Print out lines 110 through 170.
```

```
110           .GLOBL   RTTY,WTTY
130 ; COMMENT
135 ; ADD THIS LINE
140 ;
160 $SV3:     .WORD    0
170 TTY       =        1*8

READY

REP SOURCE (CR)                          Replace file "SOURCE" with this corrected
                                         version.
READY
```

More sophisticated editing techniques are available and are described in the General Electric Manual, EDITING COMMANDS, 3400.01F.

RUNNING THE ASSEMBLER

Once the program has been stored (by using the SAVE or REPLACE command), it may be assembled into IMP-16 binary code by running the assembler. To execute the assembler, the user must type:

```
RUN ASM16$ (CR)
```

The system then loads and executes the IMP-16 assembler. When the assembler begins execution, it types:

```
ENTER SOURCE,OBJECT & LISTING FILENAMES
```

The user should then type the name of the disk file that contains the source program to be assembled, the name of the file that he wants the binary code to be saved on and the file to contain the assembly listing. If the last file name is blank, the assembly listing will appear at the Teletype. The following example illustrates this procedure.

```
READY
RUN ASM16$ (CR)
ASM16$       16:16PDT      02/15/74
ENTER SOURCE, OBJECT & LISTING FILENAMES?INPUT,OBJECT,LISTING (CR)
PROGRAM STOP AT 0
USED      5.61 UNITS
```

If the object or listing (output) files do not exist, the program will create them. If they do exist, the program will write over their current contents.

OBTAINING PRINTOUT

On-line Method

After the assembly is completed, the user may cause his assembly listing to be printed on his terminal by typing:

```
LIST FILENAME (CR)
```

Where "filename" is the filename of the listing output file given in response to ENTER SOURCE, OBJECT & LISTING FILENAMES? during the assembly.

Off-line Method

The user may instead request an off-line listing on the General Electric line printer by the use of Remote Media Service (RMS). A description of RMS is contained in the General Electric MARK-III Manual 3710.04A available from your local General Electric timesharing representative.

AUXILIARY PROGRAMS

RLM Output

If the user desires to punch his object file in a format acceptable to IMP-16 loaders (described in reference 3), he may execute the program PRLMG$ by typing:

```
RUN PRLMG$ (CR)
```

The system will then respond with

```
OBJECT AND OUTPUT FILENAMES, CARD/PPT
```

The user should respond with the name of the object file from his assembly run, his output file (the system will create one if it doesn't exist) and either CARD or PPT for a card file or a paper tape file. Consider the following example where a card image file is desired:

```
READY

RUN PRLMG$ (CR)

PRLMG$        16:35EDT      03/08/74

OBJECT AND OUTPUT FILENAMES,CARD/PPT?OBJECT,OUTPUT,CARD (CR)

PROGRAM STOP AT 670

USED      1.17 UNITS

LIST OUTPUT (CR)

OUTPUT        16:36EDT      03/08/74

-RLM
00102DDB000000115454594 94F0054454C4554595045204 94E5055542E4F55545055542
4009F265A00052545459000000015754545900000000A0000000000000000000000000000
8005000200020000000000000000000000000000000000000000000000000000000000000
800B39070002000200000000 4C0004021C0121FD2903800002000000000000000000000
800A1212000200 0B00000000 4C000670 1C0121FD800002000000000000000000000000
C00414E500000000A98A6B5B0000000000000000000000000000000000000000000000000
```

A card deck of the RLM file may be obtained from General Electric, through the use of the Remote Media Service (RMS). This service must be validated by General Electric Company before being used. Contact your representative of the General Electric, Timesharing Computer Service to have your user number or numbers validated for RMS. Operation of RMS is described in the General Electric Manual, RMS Remote Media Service, Publication Number 3710.04B. See Reference 9.

If the user desires a paper tape, it is not necessary to provide an output file. After the user has answered the program query, but before the carriage return key is pressed, the paper tape device should be turned on and, if the machine is so equipped, the transparency switch should be turned on. The following example illustrates this procedure:

```
RUN PRLMG$ (CR)
PRLMG$          16:35EDT      03/08/74
OBJECT AND OUTPUT FILENAMES, CARD/PPT?OBJECT,,PPT (CR)
PROGRAM STOP AT 670
USED      1.7 UNITS
```

CR BOOT OUTPUT

The program PCRB$ reads RLMs (as output by the IMP assembler) and places hex card images suitable for later punching onto a user-specified file. These cards are, in turn, suitable for loading directly into IMP-16 memory by CRBOOT. Each card contains the hex equivalent of 18 consecutive memory words in the following format:

Column	Contents
1 - 72	Memory words i through i+17
73 - 76	First four characters of title of first RLM
77 - 80	Sequence number

To run PCRB$ the user types:

```
RUN PCRB$ (CR)
```

The system will respond with:

```
INPUT OBJECT FILE AND OUTPUT FILE?
```

The user should respond with the name of the file that the assembler placed his object code on and the name of the file to store the card images on. The user may request an off-line punch of his output file by the use of Remote Media Service (RMS). A description of RMS is contained in General Electric's MARK-III Manual 3710.04A (reference 9) available from your local General Electric timesharing representative. Consider the following example:

```
READY
RUN PCRB$ (CR)
PCRB$           17:28EDT      03/08/74
INPUT OBJECT AND OUTPUT FILENAMES?OBJECT,OUTPUT (CR)
PROGRAM STOP AT 1760
USED        .42 UNITS
LIST OUTPUT (CR)
OUTPUT          17:29EDT      03/08/74
000000004C0004021C0121FD2903800002000000000004C000607 1C0121FD800002000007
*
READY
```

PROM TAPE

The program PROM$ reads RLMs (as output by the IMP assembler) and punches them onto a paper tape in a format suitable for input to a PROM programmer. RLMs input to this program must be assembled as an ASECT and preallocated to the correct area in memory. The format of the generated tape is described in Part 1 of this manual under the heading, Tape Format.

To use PROM$, type:

```
RUN PROM$ (CR)
```

The system will then respond with:

```
OBJECT FILE?
```

The user should type in the name of his object output file from his assembler run, turn on the paper tape unit and transparency switch (if the terminal has this feature) and hit a carriage return. The following example illustrates this:

```
READY


RUN PROM$ (CR)

PROM$          13:23EDT      03/08/74

OBJECT FILE NAME?OBJECT (CR)

BPNNNNNNPFBPPPPNNNPFBNNPNNNNPFBNNPNNNNPF
BPPPPNNNPFBNNPNNNNPFBPNPNNNNNFBNNPNNNNPF
BNNNPNNNPFBNNPNNNNPFBNPNPNNNNFBPPPPNNNPF
          •       •       •
          •       •       •
          •       •       •
          •       •       •
          •       •       •
BPNNNPNNPFBPPPNPNNPFBNNPNNNNPFBPNNNPNNPF
BPPPNPNNPFBNNPNNNNPFBNNPNNNNPFBPNNNNPNPF
BPPPNNPNPFBNNPNNNNPFBNNPNNNNPFBNNPPNNNNF
          •       •       •
          •       •       •
BNPNPPPNNFBNPNPPNPPFBNNNNNNNPFBNPPPPPPNF
BNPNPPNNPFBNPPPPPNNFBNNNNPNPNFBNPNPNPPPF
BNNNNNNNPFBNPPPPNNNFBNNNNNNNPFBNPNPPPPPF
BNNNNNNNPFBNPPPNPNNFBNNNNNNNNFBNPNNPPNPF
          •       •       •
          •       •       •
BNNNPNPNPFBNNNNNNNPFBPNNNNPPPFBNNNPPNNPF
BNNNNPNPNFBNNNNNNNPFBPNNNNNPPFBPNNNNNNPF
          •       •       •
          •       •       •
          •       •       •
BNNNPPNNPFBNNNPPNNPFBPNNNPNPPFBNNNPNPPPF

PROGRAM STOP AT 2120

USED      1.21 UNITS
```

Appendix A

EXECUTING BATCH REQUESTS ON TYMSHARE

When operating on TYMSHARE, the user may obtain output from any of his runs off-line at the computer by executing a BATCH request.

Before executing a BATCH request, the user must set his file protection to PUBLIC, READ and his directory status to PUBLIC, SHARABLE, LISTABLE (see TYMEX manual, section 4). Listing output (L16, L8) and object (O16, O8) files will be automatically created with this protection status but the user must use the TYMEX command

- FDC ↵

to set his directory status. After the BATCH request has been completed by the computer center, he may reset the protection on his files by using the DECLARE command (TYMEX manual, pages 19-22) or on his directory by using the FDC command.

A BATCH request creates a request for batch processing in a file accessible by computer center personnel. The program asks certain questions, and then allows the user to describe the work to be done in free form, as well as allowing him to enter delivery instructions in free form.

The user executes a BATCH request in TYMEX mode by typing

- R BATCH ↵

The program first types an identifying line and prompts for a command by typing colon (:). At this point, the user may ask for assistance by typing HELP ↵ or begin execution of the request by typing RUN ↵. If the user types RUN, the program then asks the user if his file directory protection and file protection have been declared accordingly (see above). If the user responds with "Y", the program acknowledges and then types the computer number, date, and time, and asks the following questions.

Question	Reply	Terminating Character
COMPANY NAME	Name of the company	carriage return
USER NAME	User name under which requested work is located	carriage return
PROJECT CODE	Project code	carriage return
TELETYPE NO. (EXT)	Telephone number (area code and extension, if applicable)	carriage return
REQUESTED BY	Name of individual requesting this work	carriage return
RECEIVED BY	Your name if different from above entry	carriage return
DESCRIPTION OF WORK	Free form description of what is to be done	D^c
DELIVERY INSTRUCTIONS	Address for dispatching finished work (also entered in free form)	D^c

NOTE

A^C (TYMEX) or a RUBOUT (PDP-10) may be used to delete characters up to but not including the last carriage return.

After the above information is entered, the program types

REQUEST COMPLETED PRR #nnnnn

The notation nnnnn is the request number and may be used to refer to the request when asking for request status or for the output generated. Generally, output will not be available at the computer center until the next day.

A printout of all the information entered above will be delivered with the output generated.

Examples of BATCH requests are included in Appendix B.

Appendix B

COMPUTER PROGRAM EXAMPLES RUN ON TYMSHARE

1. Create New File

```
-CREATE TTYIO
*TABS 9,17,33
*APPEND
        .TITLE  TTYIO,'TELETYPE INPUT-OUTPUT'
        .GLOBL  RTTY,WTTY
;
;       RTTY - READ A CHARACTER FROM TTY INTO AC0.
;
        .LOA\A\CAL
$SV3:   .WORD   0
TTY     =       1
READ    =       2
RTTY:   ST      R3,$SV3
        LI      R3,TTY
$RTY1:  RIN     READ
POA     =       12
        BOC     POA,$RTY2
        JMP     $RTY1
$RTY2:  JSR     WTTY
        LD      R3,&\&\$SV3
        RTS
;
;       WTTY - WRITE A CHARACTER TO TY\Y\TY FROM AC0.
;
        .LOCAL
$SV3:   .=.+1
WRITE   =       7
WTTY:   ST      R3,$SV3
        LI      R3,TTY
$WTY1:  ROUT    WRITE
        BOC     POA,$WTY2
        JMP     W\W\$WTY2\2\1
$WTY2:  LD      R3,$SV3
        RTS
        .END
*W TTYIO
690 CHRS
*Q
```

2. Assemble New File

```
-DEL TTYIO.L16,TTYIO.016
R(NSC)ASM16
ENTER SOURCE FILE NAME TTYIO
EXIT
-
```

3. List Listing File on Terminal

```
-TYPE TTYIO.L16/FOR
1REVISION-C 11/20/72                                    20-JAN-73   11:5
3 31.1
 TTYIO    TELETYPE INPUT-OUTPUT                         PAGE NUMBER    1

     1 0000                  .TITLE  TTYIO,'TELETYPE INPUT-OUTPUT'

     2 0000                  .GLOBL  RTTY,WTTY

     3 0000          ;

     4 0000          ;       RTTY - READ A CHARACTER FROM TTY INTO AC0.

     5 0000          ;

     6 0000                  .LOCAL

     7 0000 0000 A $SV3:     .WORD   0

     8 0001 0001 A TTY       =       1

     9 0001 0002 A READ      =       2

    10 0001 A000 A RTTY:     ST      R3,$SV3

*                                     ??

UNDEFINED SYMBOL
ILLEGAL EXPRESSION MODE
    11 0002 4C00 A           LI      R3,TTY
*                                     ?

UNDEFINED SYMBOL
    12 0003 0402 A $RTY1:    RIN     READ

    13 0004 000C A POA       =       12

    14 0004 1C01 A           BOC     POA,$RTY2

    15 0005 21FD A           JMP     $RTY1

    16 0006 2903 A $RTY2:    JSR     WTTY

    17 0007 8000 A           LD      R3,$SV3

*                                     ??
```

```
UNDEFINED SYMBOL
ILLEGAL EXPRESSION MODE
   18 0008 0200 A          RTS

   19 0009         ;

   20 0009         ;       WTTY - WRITE A CHARACTER TO TTY FROM AC0.

   21 0009         ;

   22 0009                 .LOCAL

   23 0009 000A T $SV3:    .=.+1

   24 000A 0007 A WRITE    =       7

   25 000A A000 A WTTY:    ST      R3,$SV3

*                                   ??

UNDEFINED SYMBOL
ILLEGAL EXPRESSION MODE
   26 000B 4C00 A          LI      R3,TTY

*                                   ?

UNDEFINED SYMBOL
   27 000C 0607 A $WTY1:   ROUT    WRITE

   28 000D 1C01 A          BOC     P0A,$WTY2

   29 000E 21FD A          JMP     $WTY1

   30 000F 8000 A $WTY2:   LD      R3,$SV3

*                                   ??

UNDEFINED SYMBOL
ILLEGAL EXPRESSION MODE
   31 0010 0200 A          RTS

   32 0011                 .END

   *****        10 ERRORS IN ASSEMBLY      *****
1REVISION-C 11/20/72                                20-JAN-73   11:5
3 31.1
 TTYIO    TELETYPE INPUT-OUTPUT                     PAGE NUMBER    2
```

```
$RTY1" $RTY2" $SV3"  $SV3#  $WTY1# $WTY2# POA    READ   RTTY   TTY
0003 T 0006 T 0000 T 0009 T 000C T 000F T 000C A 0002 A 0001 T 0001 A

WRITE  WTTY
0007 A 000A T

   AF28    6A5B
```

4. Correct Source File Using EDITOR

```
-EDI
*R TTYIO
690 CHRS
*'TTY  'E
TTY     =       1
TTY     =       1*8
*.+1I
R3      =       3
*W TTYIO
 OLD FILE
710 CHRS
*Q
```

5. Modify Directory Status To Allow BATCH Request

```
-FDC
ALLOW ACCOUNT:
  SHARABLE? Y
  NEW FILES? Y
  LISTABLE? Y
PUBLIC:
  SHARABLE? Y
  NEW FILES? N
  LISTABLE? Y

REDC

ACCOUNT: SHARABLE NEW FILES LISTABLE
PUBLIC: SHARABLE LISTABLE
```

6. Reassemble Program

```
-DEL  TTYIO.L16,TTYIO.R16

-R(NSC)ASM16

 ENTER SOURCE FILE NAME TTYIO

 EXIT
 -
```

7. Request Listing Via BATCH Request

```
-R BATCH

PERIPHERAL PROCESSING REQUEST

: RUN

HAVE YOU DECLARED YOUR DIRECTORY AND/OR FILES(S) APPROPRIATELY? Y

COMPUTER NUMBER    C32
DATE AND TIME      02-FEB-73  16:53
COMPANY NAME       NATIONAL SEMICONDUCTOR
USER NAME          IMPSFT
PROJECT CODE       IMP16
PHONE NO. (EXT.)   732-5000 X 6288
REQUESTED BY       J. BURNETT

DESCRIPTION OF WORK

PLEASE LIST FILE TTYIO.L16 ON LARGE PAPER UNDER FORMS CONTROL

DELIVERY INSTRUCTIONS

HOLD FOR PICKUP MONDAY MORNING.

REQUEST COMPLETED       PPR #32166

THANK YOU       **TYMSHARE, INC.**

EXIT
```

8. Run PRLMT and BATCH Request To Obtain Relocatable Load Module

```
-R (NSC)PRLMT

ENTER SOURCE FILE NAME TTYIO

OUTPUT DEVICE (CDP/PTP/TTY) CDP

EXIT

-R BATCH

PERIPHERAL PROCESSING REQUEST

:RUN
```

```
HAVE YOU DECLARED YOUR DIRECTORY AND/OR FILE(S) APPROPRIATELY? Y


COMPUTER NUMBER    C32
DATE AND TIME      02-FEB-73  16:57
COMPANY NAME       NATIONAL SEMICONDUCTOR
USER NAME          IMPSFT
PROJECT CODE       IMP16
PHONE NO. (EXT.)   732-5000 X 6288
REQUESTED BY       J. BURNETT

DESCRIPTION OF WORK

PUNCH FILE TTYIO.R16 ON 80-COL. CARDS(029 CODE).

DELIVERY INSTRUCTIONS

HOLD FOR PICKUP ON MONDAY MORNING.

REQUEST COMPLETED       PPR #32232

THANK YOU,      **TYMSHARE, INC.**

EXIT
```

9. Run PRLMT To Obtain Relocatable Load Module Paper Tape at Terminal

—R (NSC) PRLMT

ENTER SOURCE FILE NAME ROMDI ↵

OUTPUT DEVICE (CDP/PTP/TTY) TTY ↵

TURN ON PAPER TAPE PUNCH

A series of spurious characters will be printed on the TTY printer as the requested paper tape is punched.

10. Run PCRBT To Obtain Bootstrappable Card Deck

```
-R (NSC)PCRBT

ENTER SOURCE FILE NAME TTYIO

EXIT

-R BATCH

PERIPHERAL PROCESSING REQUEST
```

```
: RUN

HAVE YOU DECLARED YOUR DIRECTORY AND/OR FILES(S) APPROPRIATELY? Y

COMPUTER NUMBER    C32
DATE AND TIME      05-FEB-73  13:42
COMPANY NAME       NATIONAL SEMICONDUCTOR
USER NAME          IMPSFT
PROJECT CODE       IMP16
PHONE NO. (EXT.)   732-5000 X 6288
REQUESTED BY       J. BURNETT

DESCRIPTION OF WORK

PUNCH FILE TTYIO.B16 ON 80-COL. CARDS(029 CODE).

DELIVERY INSTRUCTIONS

HOLD FOR PICKUP TOMORRR\R\OW MORNING.

REQUEST COMPLETED      PPR #32247

THANK YOU,     **TYMSHARE, INC.**

EXIT

-
```

11. Run PRLMT To Obtain RLM On Paper Tape

```
-R (NSC)PRLMT

ENTER SOURCE FILE NAME TTRIO

OUTPUT DEVICE (CDP/PTP) PTP

EXIT

-R BATCH

PERIPHERAL PROCESSING REQUEST

: RUN

HAVE YOU DECLARED YOUR DIRECTORY AND/OR FILE(S) APPROPRIATELY? Y

COMPUTER NUMBER    C32
DATE AND TIME      05-FEB-73  13:38
COMPANY NAME       NATIONAL SEMICONDUCTOR
USER NAME          IMPSFT
PROJECT CODE       IMP16
PHONE NO. (EXT.)   732-5000 X 6288
REQUESTED BY       J. BURNETT
```

```
DESCRIPTION OF WORK

PUNCH FILE TTYIO.R16 ON H/S PAPER TAPE IN ALPHABETIC MODE.

DELIVERY INSTRUCTIONS

HOLD FOR PICKUP TOMORROW MORNING.

REQUEST COMPLETED       PPR #32246

THANK YOU,      **TYMSHARE, INC.**

EXIT

-
```

12. Run PROMT To Obtain a Paper Tape for Programming P/N PROM's:

```
-R (NSC) PROMT

ENTER SOURCE FILE NAME ROMDI

TURN ON PAPER TAPE PUNCH
BNNPNNNNPFBNNPNNNNPFPNPNNPNNNFBNNPNNNNPF
BNNNPNNNPFBNNPNNNNPFBNPNPNNNNFBFPPPNNNPF
BNNPNNNNPFBNNPNNNNPFBNPNPNNNNFBPPPPNNNPF
BNNPNNNNPFBNNPNNNNPFBPNNNNNNPFBNPNPNNNNF
                        •
                        •
                        •
BPPPPNNNPFBNNPNNNNPFBNNPNNNNPFBNPNPNNNNF
BNPNNPNNNFBNNPNNNNPFBPNNNNPNPFBPNPNNPNNF
BPNNPNNNPFBPPPPNNNNFBNNPNNNNPFBNNPNNNNPF
BNPNNPPPNFBPPNNPNNPFBPNNNNNNPFBPNPPNNPNF


EXIT

—
```

Appendix C

ASSEMBLY EXAMPLE
RUN ON GENERAL ELECTRIC COMPUTER TIMESHARING SERVICE

The following is an example of an IMP-16 assembly using the source file created in the example described under the paragraph, CREATING AND EDITING USER'S PROGRAM.

```
RUN ASM16$ (CR)

ASM16$        16:16PDT       02/15/74

ENTER SOURCE, OBJECT & LISTING FILENAMES?INPUT,OBJECT,LISTING (CR)

PROGRAM STOP AT 0

USED      5.61 UNITS


1REVISION-F 10/02/73                                          04/10   17:02EDT
 TTYIO                                                        PAGE NUMBER    1

    1 0000                        .TITLE  TTYIO
    2 0000                        .GLOBL  RTTY,WTTY
    3 0000              ;
    4 0000              ;  RTTY . READ A CHARACTER FROM TTY INTO AC0.
    5 0000              ;
    6 0000                        .LOCAL
    7 0000 0000 A   $SV3:         .WORD   0
    8 0001 0008 A   TTY           =       1*8
    9 0001 0002 A   READ          =       2
   10 0001 0003 A   R3            =       3
   11 0001 ADFE A   RTTY:         ST      R3,$SV3
   12 0002 4F08 A                 LI      R3,TTY
   13 0003 0402 A   $RTY1:        RIN     READ
   14 0004 000C A   POA           =       12
   15 0004 1C01 A                 BOC     POA,$RTY2
   16 0005 21FD A                 JMP     $RTY1
   17 0006 2903 A   $RTY2:        JSR     WTTY
   18 0007 8DF8 A                 LD      R3,$SV3
   19 0008 0200 A                 RTS
   20 0009             ;
   21 0009             ;  WTTY . WRITE A CHARACTER TO TTY FROM AC0
   22 0009             ;
   23 0009                        .LOCAL
   24 0009 000A T   $SV3:         .=.+1
   25 000A 0007 A   WRITE         =       7
   26 000A ADFE A   WTTY:         ST      R3,$SV3
   27 000B 4F08 A                 LI      R3,TTY
   28 000C 0607 A   $WTY1:        ROUT    WRITE
   29 000D 1C01 A                 BOC     POA,$WTY2
   30 000E 21FD A                 JMP     $WTY1
   31 000F 8DF9 A   $WTY2:        LD      R3,$SV3
   32 0010 0200 A                 RTS
   33 0011                        .END
```

Continues on next page

```
   ******       0 ERRORS IN ASSEMBLY   ******
1REVISION-F 10/02/73                                        04/10    17:02EDT
 TTYIO                                                      PAGE NUMBER     2


 $RTY1" $RTY2" $SV3"  $SV3#  $WTY1# $WTY2# P0A     R3      READ    RTTY
 0003 T 0006 T 0000 T 0009 T 000C T 000F T 000C A 0003 A 0002 A 0001 T

 TTY     WRITE  WTTY
 0008 A 0007 A 000A T


    B320     236C
1


READY
```

National Semiconductor Corporation
2900 Semiconductor Drive
Santa Clara, California 95051
(408) 732-5000
TWX: 910-339-9240

National Semiconductor Electronics SDNBHD
Batu Berendam
Free Trade Zone
Malacca, Malaysia
Telephone: 5171
Telex: NSELECT 519 MALACCA (c/o Kuala Lumpur)

National Semiconductor GmbH
D 808 Fuerstenfeldbruck
Industriestrasse 10
West Germany
Telephone: (08141) 1371
Telex: 27649

National Semiconductor (UK) Ltd.
Larkfield Industrial Estates
Greenock, Scotland
Telephone: (0475) 33251
Telex: 778 632

NS Electronics (PTE) Ltd.
No. 1100 Lower Delta Rd.
Singapore 3
Telephone: 630011
Telex: 21402

REGIONAL AND DISTRICT SALES OFFICES

ALABAMA
DIXIE DISTRICT OFFICE
3322 Memorial Parkway, S.W. #67
Huntsville, Alabama 35802
(205) 881-0622
TWX: 810-726-2207

ARIZONA
*ROCKY MOUNTAIN REGIONAL OFFICE
7349 Sixth Avenue
Scottsdale, Arizona 85251
(602) 945-8473
TWX: 910-950-1195

CALIFORNIA
*NORTH-WEST REGIONAL OFFICE
2680 Bayshore Frontage Road, Suite 112
Mountaln View, California 94043
(415) 961-4740
TWX: 910-379-6432

NATIONAL SEMICONDUCTOR
*DISTRICT SALES OFFICE
Valley Freeway Center Building
15300 Ventura Boulevard, Suite 305
Sherman Oaks, California 91403
(213) 783-8272
TWX: 910-495-1773

NATIONAL SEMICONDUCTOR
SOUTH-WEST REGIONAL OFFICE
17452 Irvine Boulevard, Suite M
Tustin, California 92680
(714) 832-8113
TWX: 910-595-1523

CONNECTICUT
AREA OFFICE
Commerce Park
Danbury, Connecticut 06810
(203) 744-2350

*DISTRICT SALES OFFICE
25 Sylvan Road South
Westport, Connecticut 06880
(203) 226-6833

FLORIDA
*AREA SALES OFFICE
2721 South Bayshore Drive, Suite 121
Miami, Florida 33133
(305) 446-8309
TWX: 810-848-9725

CARIBBEAN REGIONAL SALES OFFICE
P.O. Box 6335
Clearwater, Florida 33518
(813) 441-3504

ILLINOIS
NATIONAL SEMICONDUCTOR
WEST-CENTRAL REGIONAL OFFICE
800 E. Northwest Highway, Suite 203
Mt. Prospect, Illinois 60056
(312) 394-8040
TWX: 910-689-3346

INDIANA
NATIONAL SEMICONDUCTOR
NORTH-CENTRAL REGIONAL OFFICE
P.O. Box 40073
Indianapolis, Indiana 46240
(317) 255-5822

KANSAS
DISTRICT SALES OFFICE
13201 West 82nd Street
Lenexa, Kansas 66215
(816) 358-8102

MARYLAND
CAPITAL REGIONAL SALES OFFICE
300 Hospital Drive, No. 232
Glen Burnie, Maryland 21061
(301) 760-5220
TWX: 710-861-0519

MASSACHUSETTS
*NORTH-EAST REGIONAL OFFICE
No. 3 New England, Exec. Office Park
Burlington, Massachusetts 01803
(617) 273-1350
TWX: 710-332-0166

MICHIGAN
*DISTRICT SALES OFFICE
23629 Liberty Street
Farmington, Michigan 48024
(313) 477-0400

MINNESOTA
DISTRICT SALES OFFICE
8053 Bloomington Freeway, Suite 101
Minneapolis, Minnesota 55420
(612) 888-3060
Telex: 290766

NEW JERSEY/NEW YORK CITY
MID-ATLANTIC REGIONAL OFFICE
301 Sylvan Avenue
Englewood Cliffs, New Jersey 07632
(201) 871-4410
TWX: 710-991-9734

NEW YORK (UPSTATE)
CAN-AM REGIONAL SALES OFFICE
104 Pickard Drive
Syracuse, New York 13211
(315) 455-5858

OHIO/PENNSYLVANIA/
W. VIRGINIA/KENTUCKY
EAST-CENTRAL REGIONAL OFFICE
Financial South Building
5335 Far Hills, Suite 214
Dayton, Ohio 45429
(513) 434-0097

TEXAS
*SOUTH-CENTRAL REGIONAL OFFICE
5925 Forest Lane, Suite 205
Dallas, Texas 75230
(214) 233-6801
TWX: 910-860-5091

WASHINGTON
DISTRICT OFFICE
300 120th Avenue N.E.
Building 2, Suite 205
Bellevue, Washington 98005
(206) 454-4600

INTERNATIONAL SALES OFFICES

AUSTRALIA
NS ELECTRONICS PTY, LTD.
Cnr. Stud Road & Mountain Highway
Bayswater, Victoria 3153
Australia
Telephone: 729-6333
Telex: 32096

CANADA
*NATIONAL SEMICONDUCTOR CORP.
1111 Finch Avenue West
Downsview, Ontario, Canada
(416) 635-9880
TWX: 610-492-1334

DENMARK
NATIONAL SEMICONDUCTOR
SCANDINAVIA
Vordingborggade 22
2100 Copenhagen
Denmark
Telephone: (01) 92-OBRO-5610
Telex: DK 6827 MAGNA

ENGLAND
NATIONAL SEMICONDUCTOR (UK) LTD.
The Precinct
Broxbourne, Hertfordshire
England
Telephone: Hoddesdon 69571
Telex: 267-204

FRANCE
NATIONAL SEMICONDUCTOR
FRANCE S.A.R.L.
28, Rue de la Redoute
92260-Fontenay-Aux-Roses
Telephone: 660-81-40
TWX: NSF 25956F

HONG KONG
*NATIONAL SEMICONDUCTOR
HONG KONG LTD.
9 Lai Yip Street
Kwun Tung, Kowloon
Hong Kong
Telephone: 3-458888
Telex: HX3866

JAPAN
*NATIONAL SEMICONDUCTOR JAPAN
Nakazawa Building
1-19 Yotsuya, Shinjuku-Ku
Tokyo, Japan 160
Telephone: 03-359-4571
Telex: J 28592

SWEDEN
NATIONAL SEMICONDUCTOR SWEDEN
Sikvagen 17
13500 Tyreso
Stockholm
Sweden
Telephone: (08) 712-04-80

WEST GERMANY
*NATIONAL SEMICONDUCTOR GMBH
8000 Munchen 81
Cosimstrasse 4
Telephone: (0811) 915-027

***Microprocessor System Specialist Available**

T10M54
©1974 NATIONAL SEMICONDUCTOR CORP. PRINTED IN U.S.A.